ENGINEERING PROCEDURE 2.1
STEEP SLOPE MINING: AOC and EXCESS SPOIL DETERMINATION

I. Introduction and Purpose:

This procedure applies to steep slope mining operations that remove all or a large portion of the coal seam or seams running through the upper fractions of a mountain and propose to return the site to AOC. Such operations include mountaintop removal mines with variances from AOC, contour mines, and mountaintop mines. Many variables, such as stability requirements, drainage requirements, and sediment control requirements, affect or determine the postmining surface configuration or shape of the land at a steep slope surface coal mining operation proposing to return the site to AOC. Incorporating compliance with these performance standards into the proposed permit application requires the applicant to carefully plan the mining and reclamation phases of the proposed surface coal mining operation. This process includes, among other requirements, plans showing: pre-mining contour maps; post-mining contour maps; cross-sections and profiles; spoil volume calculations; drainage structure designs; sediment control structure designs; access road designs (if justified); spoil placement sequences; and excess spoil determinations and calculations.

II. Policy and Procedure - Mountaintop AOC Mines:

Determining AOC Configuration:

Sufficiently detailed topographic maps, adequate numbers of cross-sections, or labeled 3-D model grids/graphics should be submitted that illustrate the representative pre-mine topography and slopes of the proposed permit area. Digital data should be submitted with the application in a format and on a media acceptable to the Knoxville Field Office (KFO).

After determining the premining configuration, the foundation for backfilling and grading is determined. The foundation is the bench that will be the starting point for placing spoil material in the mined out area to achieve AOC (see Figures 1 and 2).

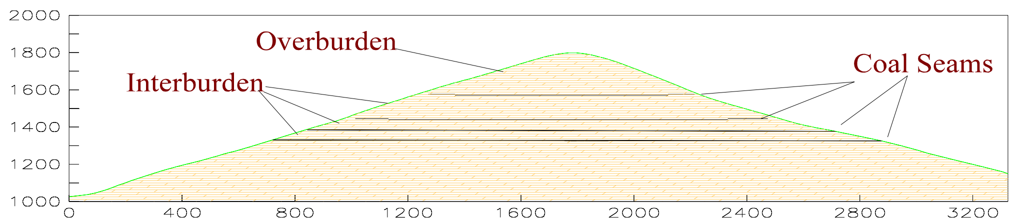


Figure 1. Pre-mining configuration

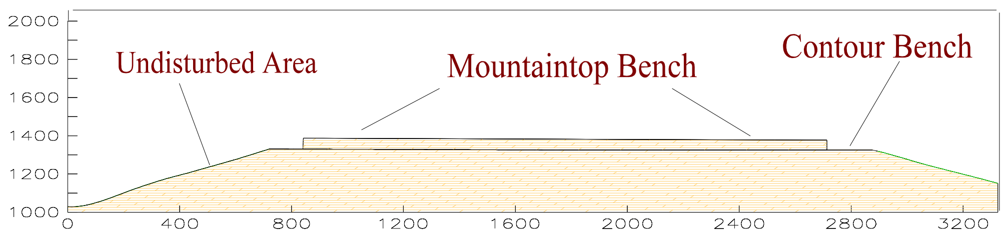


Figure 2. Foundation for backfilling and grading

From this starting point the configuration of the backfill is determined, allowing for stability requirements, drainage requirements, and sediment control requirements. Following is a discussion of how these requirements must be considered when determining the AOC configuration.

<u>Stability Requirements</u> - Spoil must be placed in the mined out area in a manner that will result in a 1.3 static safety factor.

Grading the backfill slopes (between the terraces) on a 2 horizontal to a 1 vertical ratio (2H:1V) and placing terraces, where appropriate, is a generally acceptable practice, unless it results in a safety factor of less than 1.3. Placing spoil on slopes steeper than 2H:1V is theoretically possible, but MSHA recommends that slopes not be greater (steeper) than 2H:1V, because that is the maximum safe slope for operation of tracked-equipment.

If the pre-mining slopes are less than 2H:1V (26.6°), the backfill slopes may be graded to match the pre-mining slope. In this case the backfill slopes must be at least as steep as the pre-mining slope unless the 1.3 factor of safety cannot be obtained. Steeper slopes are acceptable if stability is demonstrated.

The top of the backfill can be no wider than is necessary for safely negotiating the largest reclamation equipment utilized for the mine site. Areas larger than necessary to work this equipment would need to be approved by KFO.

Drainage Control Requirements - Drainage control may be allowed at the toe of the outslope. Erosion control measures may be incorporated by providing twenty feet wide terraces every fifty feet in vertical height. The size and location of these structures necessarily reduce backfill spoil volume because of the flat area required to properly construct effective structures and meet drainage requirements.

Sediment Control Requirements - As with drainage structures, the size and location of sediment structures dictate the amount of flat area that will displace backfill spoil storage. When reviewing the size and placement of these structures for adequacy in meeting effluent and drainage control requirements, KFO will also assess the design plans to assure the structures are no larger/wider than needed for proper design.

Access/Maintenance Roads - These structures are often necessary to gain access to sediment control structures and reclamation areas. The size and location of these roads or benches will vary throughout the minesite and should be based on documented need. If, for example, the road purpose is for cleaning sediment structures, it will be a different size than a road used for main terrace access. KFO will evaluate the necessity for roads in the final reclamation configuration and approve only those widths necessary. Typically, a twenty feet wide access road is acceptable.

Typical Backfill Configuration - The backfill slope, associated terraces, drainage conveyances, and access roads will determine the ultimate backfill height for the mined area.

This final elevation may be lower than the pre-mining elevation, approximate the pre-mining elevation, or exceed the pre-mining elevation. Applying these performance requirements in the mine planning process will determine the amount of total spoil material which must be retained in the mined out area. The resultant post-mining configuration should closely resemble the pre-mining topography, thus satisfying not only the access, drainage, sediment, and stability performance standards of SMCRA, but AOC as well. (see Figure 3).

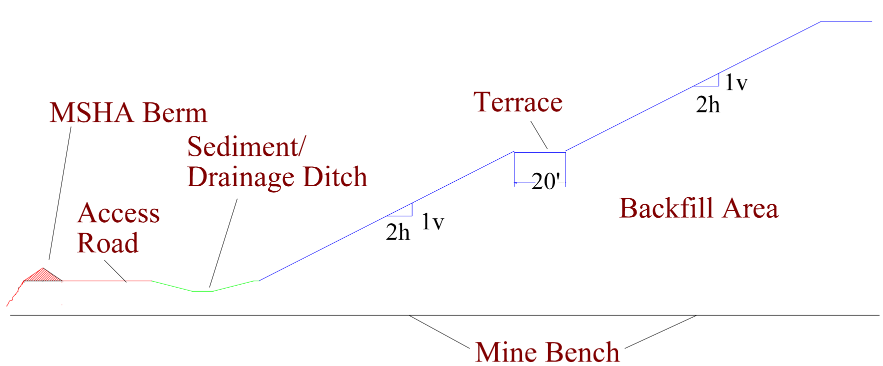


Figure 3. Typical backfill outslope configuration

As can be seen in Figure 4, this reclamation technique results in a configuration or shape that closely resembles the pre-mining configuration.

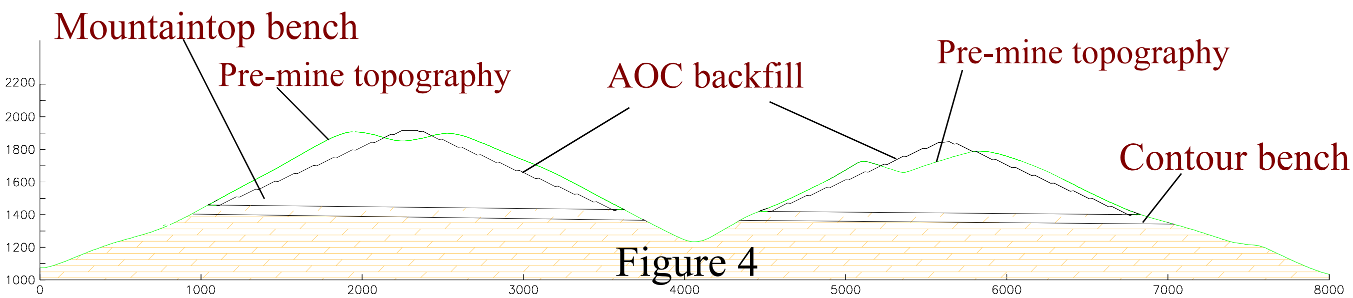


Figure 4

<u>Determining Spoil Volumes</u>:

Total Spoil Material:

Total spoil material is all overburden handled as a result of the proposed mining operation. The applicant must place total spoil material either in the mined area or in excess spoil disposal sites (valley fills or pre-existing benches). Total spoil material is determined by combining the overburden (**OB**) volume over the uppermost coal seam to be excavated with the interburden (**IB**) volumes between the remaining lower coal seams. This value is typically expressed as bank cubic yards (bcy).

Total spoil material volumes are determined by using standard engineering practices, such as average-end area, stage-volume calculations, or 3-dimensional (3-D) grid subtraction methods. KFO must have adequate information from the applicant to properly evaluate spoil volume calculations. If the applicant utilizes an average-end area method, cross-sections must be provided for a base line or lines, at intervals no less than every 500 feet, or more frequently, if the shape of the pre-mined area is highly variable between the 500-foot intervals. If the applicant utilizes a stage-storage method, planimetered areas must be provided on a contour interval that is representative and reflects any significant changes in slope (20' or less contour interval recommended). If a 3-D model is used, the applicant should provide a pre-mining contour map and, if possible, a 3-D model graphic. The applicant should identify the grid node spacings used in generating volumetrics. If the applicant utilizes digital data, it should be in a format and on a media acceptable to KFO.

Total spoil volume **(TSV)** is determined by calculating the in-situ overburden and interburden volume, multiplied by a "bulking" factor **(BF)**. Bulking factors are calculated by a two-step process: 1) "swell" volume is determined from the amount of expected expansion of in-situ material through the incorporation of air-filled void spaces; 2) "shrink" volume is calculated from the amount the swelled material compacts during placement (reducing the void spaces and, consequently, the volume). Thus, the bulking factor is the swell factor minus the shrink factor, which varies, based on the overburden lithology (e.g., sandstone swells more and shrinks less than shales). Total spoil volume is reported in cubic yards (cy), in the following equation form:

(OB + IB) x BF = TSV.

For example, if the in-situ volume of overburden material is 300,000 bcy, the interburden volume is 700,000 bcy, and the weighted bulking factor is 125%, TSV would be determined as follows:

(OB + IB) x BF = TSV
(300,000 bcy + 700,000 bcy) x 1.25 = 1,250,000 cy

Spoil Volume Required to Achieve AOC:

The applicant calculates the volume of spoil material required to be returned to the mined out area based on the configuration of the reclaimed area as determined by considerations for stability, drainage control, sediment control and access. These volumes are expressed as bulked volumes.

Excess Spoil Volume:

Spoil material unable to be placed in backfill area is excess spoil, and must be placed in an approved excess spoil disposal site(s) (see Figure 5). The excess spoil quantity is obtained by determining the difference in the total spoil volume and the volume required to backfill the mined area to AOC.
KFO will carefully evaluate the spoil balance information provided in the permit application to assure that excess spoil volumes are accurate. Permits that propose to conduct mountaintop mining operations, but change plans due to unanticipated field conditions, should submit permit revisions containing revised volumetric calculations and excess spoil designs.

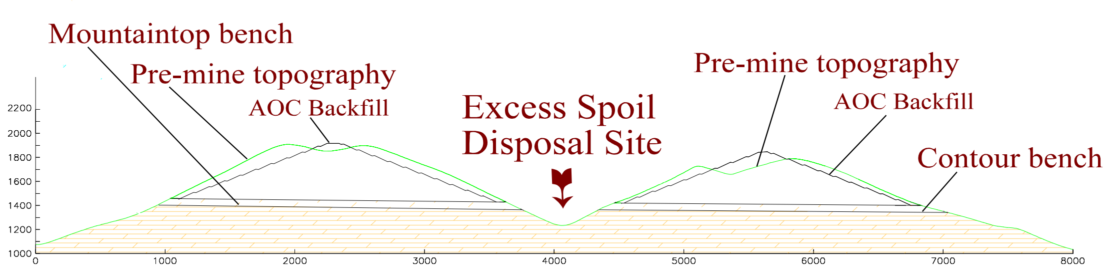


Figure 5. Potential excess spoil disposal site

Excess Spoil Disposal Sites:

Generally the volume of excess spoil, and/or mining logistics, requires more than one excess spoil disposal site. Typically, in steep-slope regions of Appalachia, excess spoil is placed in adjacent valleys. In areas where extensive "pre-law" mining has occurred, pre-existing benches are also used. Performance standards for excess spoil disposal areas are found in 30 CFR 816.71-816.73 and in 30 CFR 816.74 for pre-existing benches.

The most common site selected to place excess spoil is in the adjacent valleys. The permit application should contain the stage-storage-volume calculation for the valley capacity for excess spoil storage dependent on toe location and crest (top) elevation.

If the applicant utilizes pre-existing benches as excess spoil disposal sites, he/she must calculate the capacity of each pre-existing bench area. Typically these calculations utilize the average-end area method, based on cross-sections representing the site configuration.

The applicant must design excess spoil fills in order to attain a long-term static safety factor of 1.5 and, if a durable rock fill, an earthquake static safety factor of 1.1. The applicant may propose to construct terraces on the outslopes, where appropriate or required. The grade of the outslopes, between the terraces, may not exceed 2H:1V. Additionally, where the natural slope in the disposal area exceeds 36 percent, or such lesser slope as designated by the regulatory authority, the applicant shall construct keyway cuts or rock toe buttresses to ensure stability of the fill.

Determining the location of the toe of the fill requires the available backfill and excess spoil material to balance. After this material balance is achieved, the applicant designs the excess spoil disposal areas to accommodate this quantity of excess spoil. If the excess spoil disposal site is a valley fill, this design will determine the height or elevation of the crest of the excess spoil disposal site or fill. If the top of the fill elevation is above the elevation of the lowest coal seam mined, as illustrated in Figure 6, then the applicant must reconsider the AOC or backfill configuration.

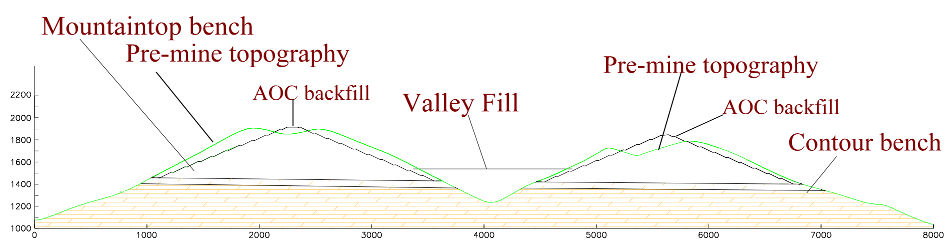


Figure 6. Sizing valley fills by material balance

At this point the applicant must make a second determination of AOC to establish the final reclamation configuration. Before performing a new AOC determination, the applicant will determine the interface between the backfill area and the excess spoil disposal area:

- Locate the outcrop of the lowest seam being mined
- Project a vertical line upward beyond the crest of the fill as shown in Figure 7.

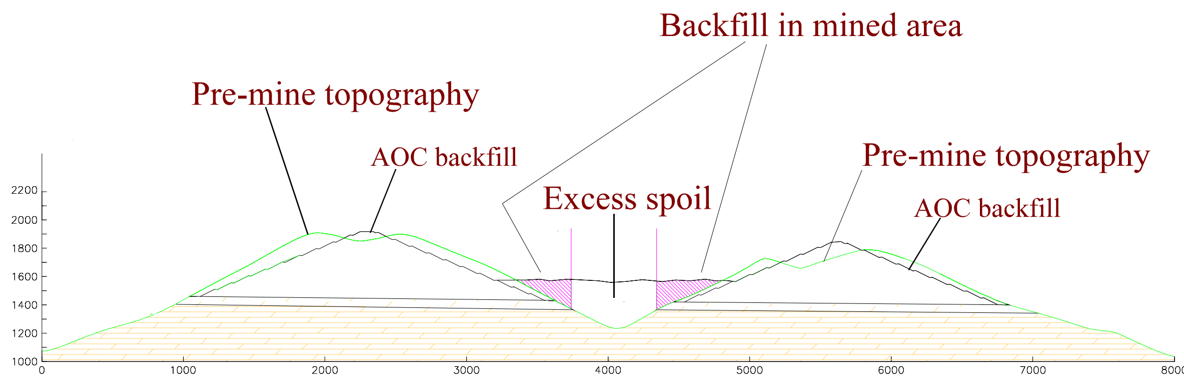


Figure 7. Distinguishing backfill and excess spoil areas

The additional material placed on the mined area as a result of this process creates the need to perform another material balance exercise. This rebalancing of material may result in a reduction of excess spoil volume. Reevaluation of fill designs, using this second iteration, becomes an important component of the permit design. Reduction in fill lengths may result in the toe of the fill being placed upon too steep of a slope requiring additional material excavation for a keyway cut, or additional material placement for stabilizing the toe buttress. The point on the crest of the fill becomes a reference line to perform the second AOC determination. Figure 8 demonstrates the second AOC determination and Figure 9 shows the final configuration.

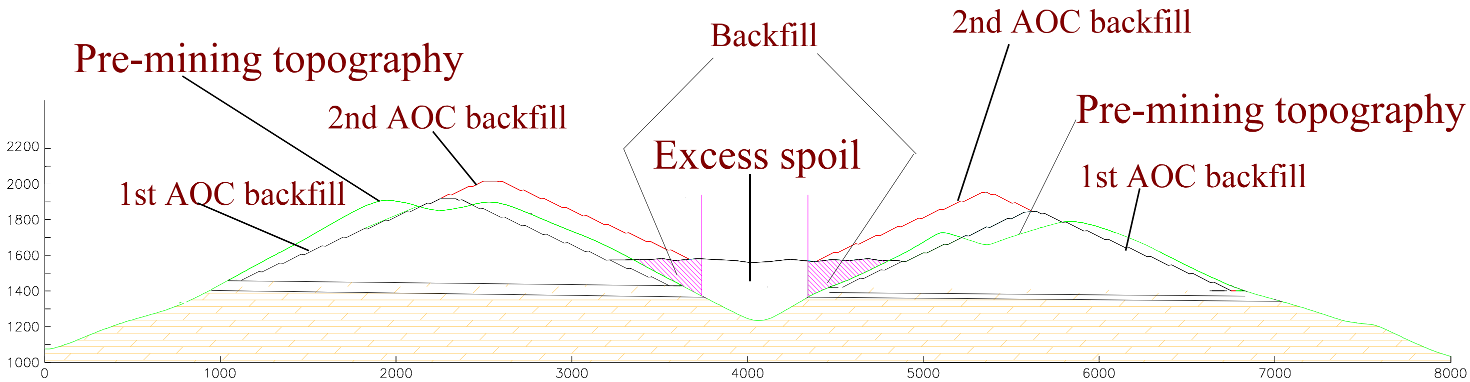


Figure 8. Second iteration-placement of additional spoil material within the mined area

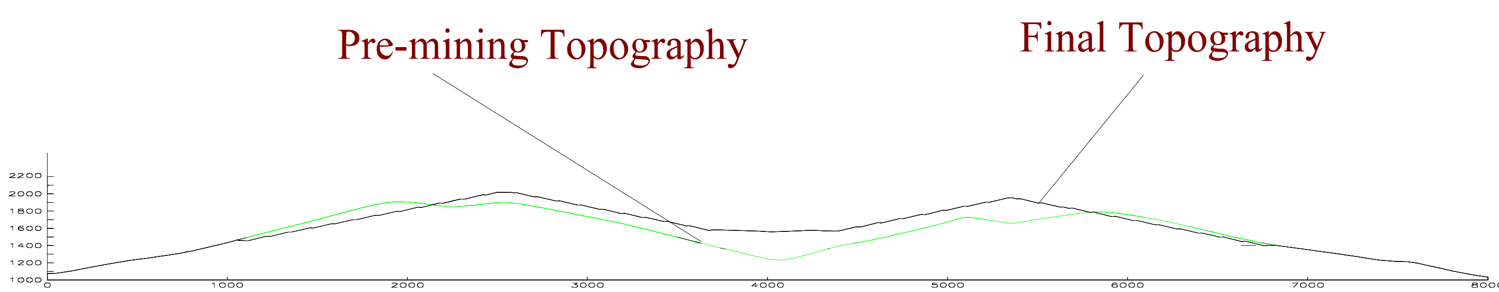


Figure 9. Configuration after AOC process

III. Policy and Procedure -Contour Mining Operations:

The AOC/excess spoil determination, described earlier, is used to determine AOC and excess spoil volumes for contour surface mining operation as well.

A contour mine typically takes one (1) contour "cut" and progresses around the coal outcrop, leaving a highwall and bench after the coal is removed. In reclaiming the site to AOC, documentation is required showing drainage structure designs, access road requirements, and properly designed sediment structures. A generally acceptable practice, unless it results in a static safety factor of less than 1.3, includes grading the backfill slopes (between terraces) on a 2H:1V slope as shown in Figure 3. However, in all cases, the highwall must be eliminated. If compliance with the other performance standards, i.e., drainage, access, and sediment control, result in backfill out-slopes being steeper than 2H:1V, the application should contain adequate documentation that the backfill configuration meets a 1.3 static safety factor. Documentation is not required where slopes flatter than 2H:1V are proposed.

Whenever contour mining operations encounter long, narrow ridges or points (see Figure 10), the same principles and performance standards apply, i.e. stability, drainage, sediment control, and access requirements.

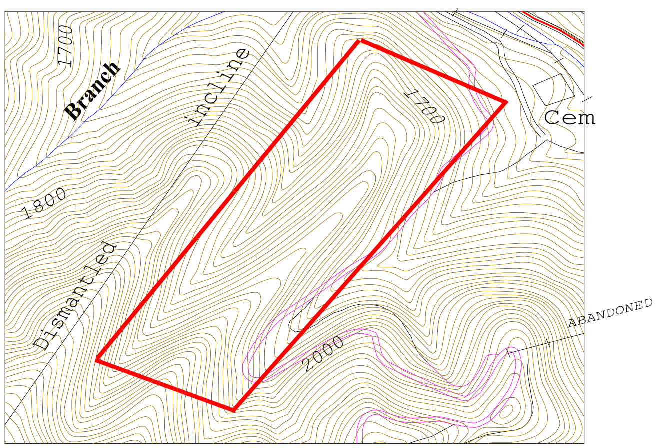
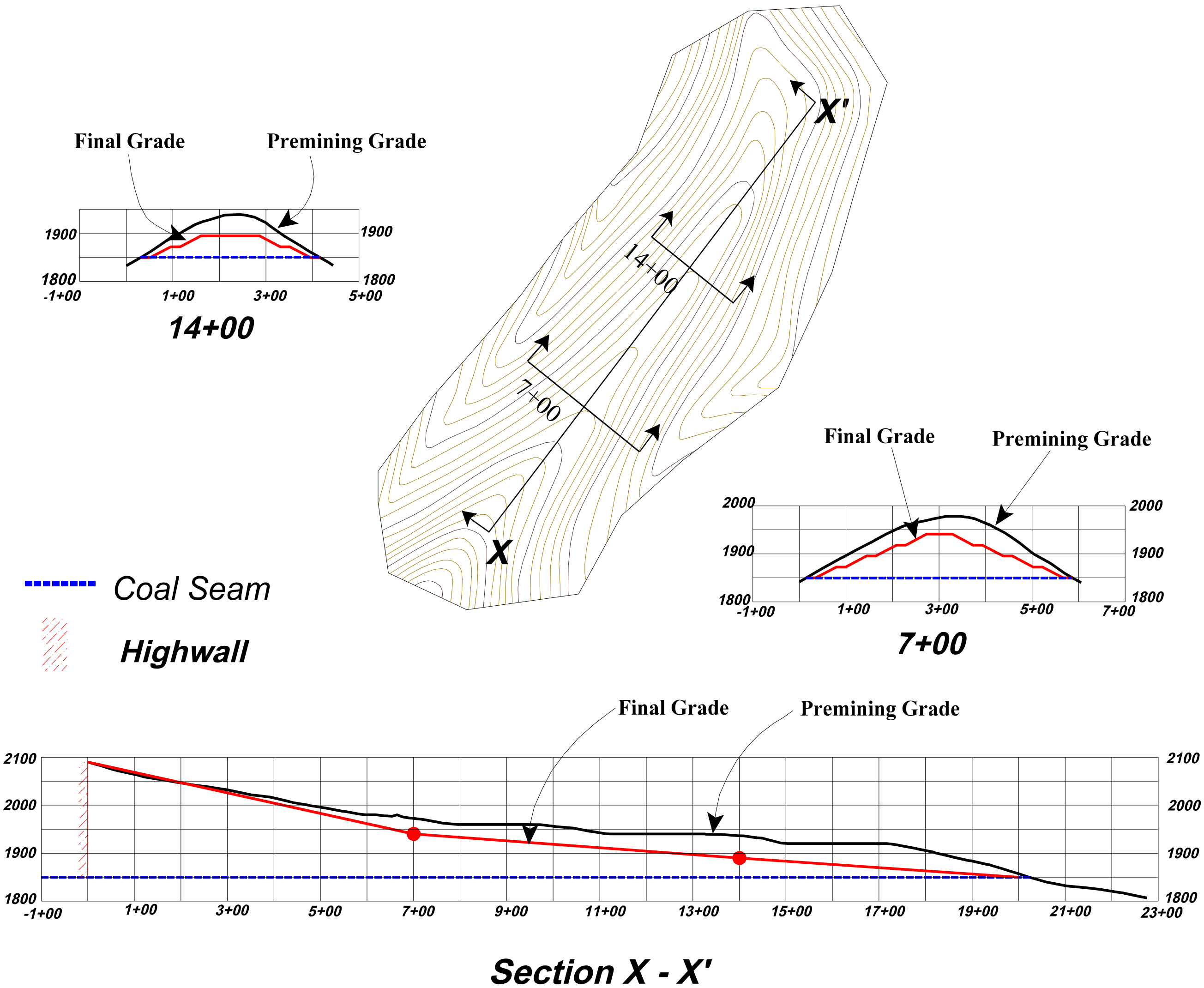


Figure 10

In order to determine the AOC configuration for a finger ridge mining operation, the applicant must utilize orthogonal cross sections (see Figure 11). A single longitudinal cross section running down the ridge line and perpendicular to the highwall is not adequate. Additional cross sections perpendicular to the longitudinal cross section are also required to determine the final backfill configuration. Often returning these sections to 2H:1V dictates the AOC configuration and establishes the longitudinal profile (see Figure 11). The applicant must completely eliminate the highwall.


Final Grade
Premining Grade
1900
1800
-1+00
1+00
3+00
5+00
14+00
X'
X
14+00
7+00
Final Grade
Premining Grade
2000
1900
1800
-1+00
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Coal Seam
Highwall
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2100
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5+00
7+00
9+00
11+00
13+00
15+00
17+00
19+00
21+00
23+00
Section X - X'

Figure 11

IV. Policy and Procedure - Mining Operations with AOC Variances:

The determination of backfill and excess spoil volumes for mining operations proposing variances from AOC are performed in essentially the same manner as described in Section III . The difference in these calculations for AOC variances is that a certain volume of spoil material becomes excess due to regrading to flat or gently rolling terrain in the process of attaining the approved post-mining land use (PMLU). For instance, an AOC variance for an industrial area would require only that amount of backfilling in the mined area necessary for drainage controls or buried utilities for water and sewer lines. The mining plan would show the post-mining configuration necessary to achieve a landform with appropriate infrastructure and site conditions supporting the PMLU (see Figures 12 and 13).

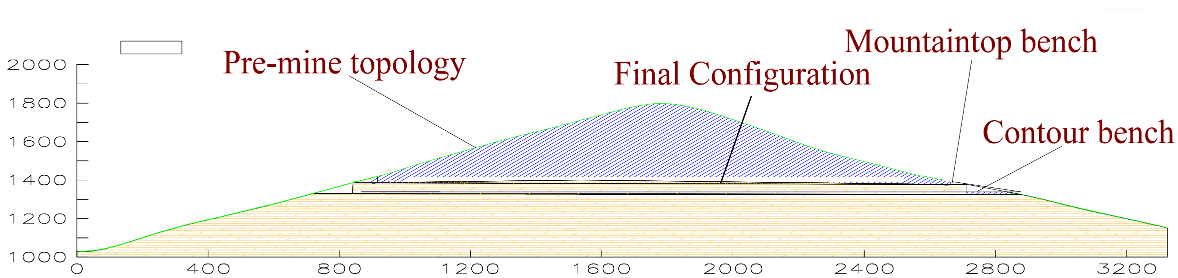

Figure 12. AOC Variance--potential industrial example

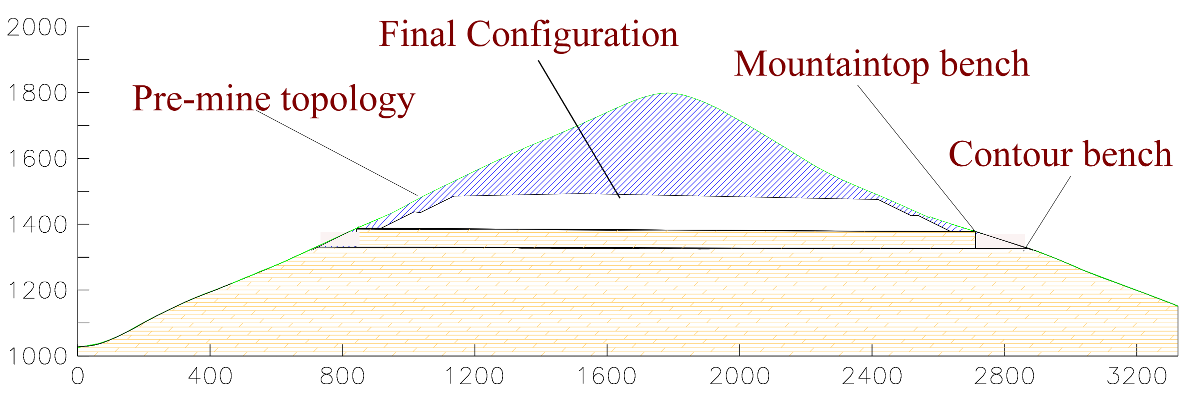

Figure 13. Other potential AOC variance configurations

KFO will carefully review the AOC variance plan to assure that excess spoil volumes do not exceed the necessary amount required for the designated PMLU in order to minimize stream and terrestrial habitat degradation. AOC reclamation variance proposals must also conform with the need, feasibility, financial assurance, and other demonstrations required by SMCRA Section 515(c)(3) and (e).

V. Related Procedures

- Slope Stability and Regulations Analysis Requirements - Engineering Procedure 8.1
- Excess Spoil - Engineering Procedure 3.0
- MSHA Regulations